

Rationale for Color Selection Used in ANSI/VITA 40-2003

Craig Hartley
Sun Microsystems
650-786-6236

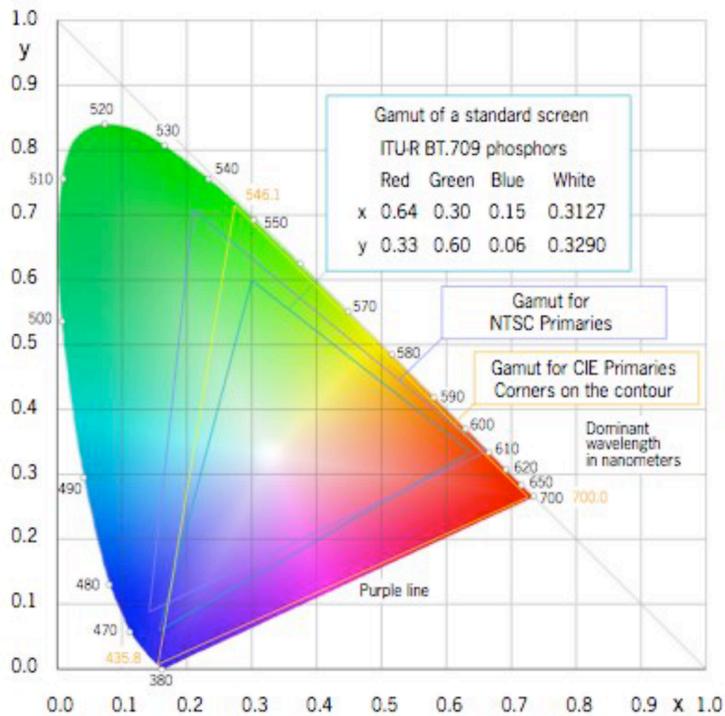
Colors specified in ANSI/VITA 40-2003 were selected to be separated from one another by approximately 3-7 color steps of 3 just-noticeable-differences (JNDs) each, according to published color research studies. Pure colors and color ranges, stated in nanometers (nm), are as defined on the CIE 1931 chromaticity diagram. These particular colors were also selected because they are technically feasible and commercially available.

The green and amber (yellow) colors specified in ANSI/VITA 40-2003:

Green = 525 nm (allowable range 505-535 nm)
Amber = 590 nm (allowable range 583-593 nm)

Reference:

Boff, KR and Lincoln, JE 1988 *Engineering Data Compendium: Human Perception and Performance*, Section 1.704, pp 332-333. AAMRL, Wright-Patterson AFB, OH



Color	Behavior	Definition	Meaning	Comment
RED 630 nm (Range: 615-650 nm) (pure red is approx. 650 nm)	OFF	steady state		
	STEADY ON	steady state	"out of service"	This indicator is not recommended for use except in specific environments like telco that require it (see section 2.7)
WHITE (defined as a point of the CIE 1931 chromaticity diagram at approximately x=0.31, y=0.32; see VITA40 text section 2.8 for an operational definition of white using data from observers)	OFF	steady state		
	FAST BLINK	4Hz repeating sequence with equal ON/OFF time	"here I am"	This indicator is designed to help users locate a particular enclosure, board, or subsystem
BLUE 470 nm (Range: 445-480 nm) (pure blue approx. is 450 nm)	OFF	steady state		
	STEADY ON	steady state	"service action allowed"	If blue is on, a service action can be performed on the applicable component with no adverse consequences.
YELLOW/AMBER 590 nm (Range: 583-593 nm) (traffic light yellow/amber is approx. 590 nm)	OFF	steady state		
	SLOW BLINK	1Hz repeating sequence with equal ON/OFF time	a new (unacknowledged) event requiring a service action has been detected	The purpose of this behavior is to make it possible to distinguish new faults from old faults
	STEADY ON	steady state	"service action required"; the event has been acknowledged but the problem still needs attention	The amber indicator stays on until the service action is completed and the system returns to normal function.
GREEN 525 nm (Range: 505-535 nm) (pure green is approx. 530 nm)	OFF	steady state		
	STANDBY BLINK	Repeating sequence consisting of a brief (0.1 sec.) ON flash followed by a long OFF period (2.9 sec.)	the system is running at a minimum level and is ready to be quickly revived to full function	This state is commonly used in laptops, energy efficient monitors, cell phones, etc.
	STEADY ON	steady state	"normal"; system or component functioning with no service actions required	
	SLOW BLINK	1Hz repeating sequence with equal ON/OFF time	a normal transitory activity is taking place for which direct proportional feedback is not needed or not feasible	This behavior is used to provide feedback that a transitory event is taking place. Slow blink is a temporary state. (e.g., POST) for which FEEDBACK FLASH is not feasible or appropriate.
	FEEDBACK FLASH	Indicator is ON, but goes OFF during activity	a normal activity is taking place for which direct, proportional feedback is desirable	This behavior is used to provide feedback that normal activity is taking place. e.g., flickering light on a disk drive as it reads and writes data

Table 2.2-2 from ANSI/VITA 40. The colors, behaviors, and meanings assigned to indicators.

Note: Colors have been selected to be separated from one another by approximately 3-7 color steps of 3 just-noticeable-differences (JNDs) each, according to published color research studies. Pure colors and color ranges are as defined on the CIE 1931 chromaticity diagram.

(Ref.: Boff, KR and Lincoln, JE 1988 *Engineering Data Compendium: Human Perception and Performance*, Section 1.704, pp 332-333. AAMRL, Wright-Patterson AFB, OH

The sections below are from ANSI/VITA 40-2003

2.3 Green

Green is commonly used to denote normal function. Many standards specify meanings for green. For example, MIL-STD-1472F section 5.2.2.1.13 states that "green shall be used to indicate that the monitored equipment is in tolerance or a condition is satisfactory and that it is all right to proceed (e.g., "in-tolerance", "ready", "function activated)". Similarly, Telcordia Standard GR-2914-CORE states that, "green shall indicate satisfactory operation, active condition, or completion of a process or procedure." International standard CEI IEC 73 section 4.2.1.1 assigns the meaning to green as a "normal" state of equipment or a "normal" condition of a process.

Rule 2.3-1: The meaning of green

Green shall mean "OK", "normal", "satisfactory operation", "active", or "in service". It indicates satisfactory operation, active condition, or completion of a process or procedure.

Rule 2.3-2: The permitted states of green

The permitted states or behaviors of green shall be OFF, STEADY ON, SLOW BLINK, STANDBY BLINK, and FEEDBACK FLASH. (Descriptions of these states are presented in section 3.2 above.)

Rule 2.3-3: Application of green

The green indicator shall apply only to the component or system on which it appears, i.e., the normal condition being indicated shall be isolated to the individual component or system.

2.4 Yellow or Amber

Yellow is commonly used to denote that the system or component requires attention or a service action, or that something is not functioning normally. MIL-STD-1472 states that, "yellow shall be used to advise an operator that a condition exists which is marginal" or "...to alert the operator to situations where caution, recheck, or unexpected delay is necessary." Telcordia GR-2914-CORE states that, "yellow or amber shall indicate minor failure, caution, warning, temporary malfunction, or state for which the craftsperson should use caution." International standard CEI IEC 73 section 4.2.1.1 assigns the meaning to yellow as an "abnormal" state of equipment or an "abnormal" condition of a process. The intent of yellow in this standard is to provide indication that a problem exists somewhere on the component or system.

Rule 2.4-1: The meaning of yellow or amber

Yellow or amber shall mean "attention" or "service action required". Yellow or amber indicates a minor failure, caution, warning, or temporary malfunction, or state for which the service person should use caution.

Rule 2.4-2: The permitted states of yellow or amber

The permitted states of yellow or amber shall be OFF, STEADY ON, and SLOW BLINK. (Definitions of these states are presented in section 3.2 above.)

Rule 2.4-3: The application of yellow or amber

The yellow or amber indicator shall apply only to the component or system on which it appears, i.e., the attention condition being indicated shall be isolated to the individual component or system.

The yellow or amber indicator functions as a fault indicator or annunciator. In many operational environments it is useful to be able to distinguish new fault conditions from conditions that are already known to the system operators. The ability to discern new faults from old can provide valuable information and feedback that can significantly increase the probability of error detection, minimize service errors, and reduce mean-time-to-repair. It is common practice in process-industry and aircraft-cockpit caution and warning (annunciator) panels to have fault indicators blink until acknowledged and then stay on until the fault is corrected. The SLOW BLINK state serves to call attention to the indicator while the STEADY ON state indicates the system or component status. This basic provision is described in Telcordia GR-2914-CORE in rules R4-21 and R4-22, which apply to the user interface on the console associated with the network equipment.

Recommendation 2.4-1: Distinguishing "new" conditions from "old" conditions

Provision should be made for distinguishing new "attention" conditions from old (acknowledged) "attention" conditions by setting the state of yellow to SLOW BLINK when new conditions occur and changing the state of the yellow indicator to STEADY ON when the new condition has been acknowledged through the service management facility.

Observation 2.4-1: How acknowledgement of new faults may be implemented

This standard does not specify how the system knows which conditions are acknowledged nor how to acknowledge them. Implementation is left to the board or system designer based on the requirements established for operational concept described in Recommendation 2.1-1 above. Examples of how acknowledgement might be made include automatic processes in the error alarm system, console commands, or an acknowledgement pushbutton on the board or enclosure.

Observation 2.4-2: Definition of "system management facility" for acknowledging conditions

A system management facility could consist of a console command, an automatic command from an on-board service processor, or even hardwired logic.

Observation 2.4-3: Use of the word "yellow" instead of "amber"

This document uses "yellow" to describe the "service action required" indicator. In reality, the color spectrum recommended is around 590 nm, which is best described as the color amber. Many potential users of the standard are not as familiar with amber as a color and often think of it as "yellow". "Yellow" is generally better understood than "amber".

Some Definitions:

Chroma: The attribute of visual perception in accordance with which an area appears saturated with a particular color or hue. Example: a red apple is high in chroma; pastel colors are low in chroma; black, white and gray have no chroma (this attribute of color is used in the color model L^*C^*H - Lightness, Chroma, Hue); also referred to as Saturation.

Chromaticity, Chromaticity Coordinates: Dimensions of a color stimulus expressed in terms of hue and saturation, or redness-greenness and yellowness-blueness, excluding the luminous intensity. Generally expressed as a point in a plane of constant luminance. See CIE xy Chromaticity Diagram.

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CIE (Commission International de L'Eclairage): A French name that translates to International Commission on Illumination, the main international organization concerned with color and color measurement.

CIELAB (OR CIE $L^*a^*b^*$, CIE Lab): Color space in which values L^* , a^* and b^* are plotted at right angles to one another to form a three dimensional coordinate system. Equal distances in the space approximately represent equal color differences. Value L^* represents Lightness; value a^* represents the Redness/Greenness axis; and value b^* represents the yellowness/blueness axis. CIELAB is a popular color space for use in measuring reflective and transmissive objects.

CIE Standard Illuminants: Known spectral data established by the CIE for four different types of light sources. When using tristimulus data to describe a color, the illuminant must also be defined. These standard illuminants are used in place of actual measurements of the light source.

CIE Standard Observer: A hypothetical observer having the tristimulus color mixture data recommended in 1931 by the CIE for a 2° viewing angle. A supplementary observer for a larger angle of 10° was adopted in 1964. If not specified, the 2° Standard Observer should be assumed. If the field of view is larger than 4° , the 10° Standard Observer should be used.

CIE Xy Chromaticity Diagram: A two-dimensional graph of the chromaticity coordinates, x as the abscissa and y as the ordinate, which shows the spectrum locus (chromaticity coordinates of monochromatic light, 380-770nm). It has many useful properties for comparing colors of both luminous and nonluminous materials.

CIE Tristimulus Values: Amounts (in percentages) of the three components necessary in a three-color additive mixture required for matching a color: in the CIE System, they are designated as X, Y and Z. The illuminant and standard observer color matching functions used must be designated; if they are not the assumption is made that the values are for the 1931 CIE 2° Standard Observer and Illuminant C.

CIE xyz Chromaticity Coordinates: Plotted to form the xyY chromaticity diagram which visually represents the gamut of vision for the 1931 CIE 2° Standard Observer. Calculated from the CIE XYZ Tristimulus Values.

Color gamut: Space of colors on the chromaticity diagram (represented as a triangle) that a physical device can represent by mixing its primary colors

Nanometer (nm): Unit of length equal to a 10^{-9} meter, or one millionth of a millimeter. Wavelengths are measured in nanometers.